

CLAIMS:

1. A composite system for protecting a substrate from a fire or other hyperthermal conditions, the system comprising a lower layer of an active fire protective material and an upper layer of an ablative fire protective material, the ablative material forming an open cell matrix when exposed to hyperthermal conditions to permit passage of gasses from the lower layer to ambient.

2. The system of claim 1 wherein the upper layer comprises at least about 7% by weight inert fillers.

3. The system of claim 1 wherein the upper layer comprises at least 15% by weight inert fillers.

4. The system of claim 1 wherein the upper layer comprises at least 20% by weight inert fillers.

5. The system of claim 2 wherein the inert fillers are selected from the group comprising glass, graphite, and ceramic.

6. The system of claim 2 wherein the inert fillers increase reradiation of heat by the upper layer.

7. The system of claim 1 wherein the system is capable of protecting against jet fires for a period of time at least 30% greater than is provided by a coating of the same thickness of either the upper layer or the lower layer.

8. The system of claim 1 further comprising a mesh or fabric reinforcement embedded in the system.

9. The system of claim 1 wherein the lower layer has a thickness of about 1 to about 25 mm.

10. The system of claim 1 wherein the lower layer has a thickness of about 2 to about 15 mm.

5 11. The system of claim 10 wherein the upper layer has a thickness of about 2 to about 6 mm.

12. The system of claim 1 wherein the upper layer has a thickness of about 1 to about 25 mm.

10 13. The system of claim 1 wherein the upper layer has a thickness of about 1 to about 6 mm.

14. A composite system capable of protecting a substrate from a jet fire, the system comprising a lower layer of an active fire protective material which swells when exposed to a fire or other hyperthermal condition and an upper layer of an active fire protective material which swells when exposed to a fire or other hyperthermal condition, the upper layer swelling less than the lower layer, the upper layer comprising a fill of refractory material comprising at least about seven percent of the upper layer by weight.

15. The system of claim 14 wherein the upper layer comprises at least 15% by weight refractory material.

20 16. The system of claim 14 wherein the inert fillers are selected from the group comprising glass, graphite, and ceramic.

17. The system of claim 14 wherein the system is capable of protecting against jet fires for a period of time at least 30% greater than is provided by a coating of the same thickness of either the upper layer or the lower layer.

18. The system of claim 14 further comprising a mesh or fabric
5 reinforcement embedded in the system.

19. The system of claim 14 wherein the lower layer has a thickness of about 1 to about 25 mm.

20. The system of claim 14 wherein the lower layer has a thickness of about 2 to about 6 mm.

10 21. The system of claim 20 wherein the upper layer has a thickness of about 2 to about 6 mm.

22. The system of claim 14 wherein the upper layer has a thickness of about 1 to about 25 mm.

15 23. The system of claim 1 wherein the upper layer has a thickness of about 1 to about 6 mm.

24. A method for protecting a substrate from hyperthermal conditions comprising a first step of applying a layer of a first active thermal protective composition to the substrate, and thereafter a second step of applying an upper layer of a second active thermal protective composition to the first layer, the
20 second composition comprising a fill of a refractory material comprising at least about seven percent of the second composition by weight.

25. The method of claim 24 wherein both the first composition and the second composition comprise a polymeric binder and a gas former, the second composition comprising less gas former by weight than the first composition, the method providing a composite system overlying the substrate.

5 26. The method of claim 25 comprising a further step of embedding a high-temperature mesh or fabric reinforcement in the composite system.

27. The method of claim 26 wherein the reinforcement comprises a graphite fabric.

10 28. The method of claim 26 wherein the reinforcement comprises a metal mesh.

29. The method of claim 24 wherein lower layer is applied to a cured thickness of about one to about twenty-five mm.

30. The method of claim 29 wherein the lower layer is less than 15 mm thick.

15 31. The method of claim 24 wherein the lower layer responds to hyperthermal conditions by expanding to at least twice its original thickness.

32. The method of claim 24 wherein the upper layer is applied to a cured thickness of about one to about fifteen mm.

20 33. The method of claim 32 wherein the upper layer is less than about six mm thick.

34. The method of claim 24 wherein the upper layer responds to hyperthermal conditions by expanding to an average thickness no more than twice its original thickness.

35. A thermally protective composition comprising a polymeric binder,
5 from 5% to 30% of a blowing agent which changes from solid to gas at a hyperthermal temperature to which the composition may be subjected, and at least 7% of a refractory filler.

36. The composition of claim 35 wherein the refractory filler comprises both particles and fibers.

37. The composition of claim 35 wherein the filler comprises ceramic
10 particles and glass fibers.

38. The composition of claim 35 wherein the filler comprises one or more materials selected from the group consisting of glass, graphite, and ceramic.

39. The composition of claim 35 wherein the filler comprises at least
15 about 15% by weight of the composition.

40. The composition of claim 35 wherein the filler comprises about 20% to 30%, by weight of the composition.

41. The composition of claim 35 wherein the blowing agent comprises 10% to 30% by weight of the composition.

42. The composition of claim 35 comprising a flexibilizing agent.

43. The composition of claim 35 wherein the composition comprises about 35% to about 65% modified epoxy resin.

44. The composition of claim 43 wherein the epoxy resin is modified with polysulfide and cured with an amine.

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